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National Atmospheric Release Advisory Center Dispersion Modeling in Response to the Fukushima Daiichi Accident

G. Sugiyama, J. Nasstrom, K. Foster, B. Pobanz, M.
Simpson, P. Vogt, F. Aluzzi, S. Homann

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Summary of talk presented at the American Meteorological Society's Special Symposium on the Transport and Diffusion of Contaminants from the Fukushima Dai-Ichi Power Plant: Present Status and Future Directions, Austin TX, 2013 January 6

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Gayle Sugiyama, John Nasstrom, Kevin Foster, Brenda Pobanz, Matthew Simpson,
Phil Vogt, Fernando Aluzzi, and Steve Homann

Lawrence Livermore National Laboratory

On March 11, 2011, the U.S. Department of Energy/National Nuclear Security Administration (DOE/NNSA) activated the National Atmospheric Release Advisory Center (NARAC) at Lawrence Livermore National Laboratory to respond to the accident at the Fukushima Daiichi nuclear power plant. Through the end of May, NARAC supported a wide range of requests providing:

- Daily weather forecasts for U.S. personnel deployed to Japan
- Estimates of possible dose in Japan for hypothetical scenarios developed in conjunction with DOE/NNSA and the U.S. Nuclear Regulatory Commission (NRC) at White House request
- Predictions of possible plume arrival times and dose for U.S. locations
- Source estimation and model refinement based on available measurement data

A more detailed discussion of NARAC's response activities can be found in Sugiyama et al., 2011: *Health Physics* **102**(5), 493-508.

During the response, NARAC source reconstruction efforts focused on March 14-16 as this was determined to be the most likely period during which deposition produced a high dose-rate area to the northwest of the Fukushima Daiichi plant, seen in DOE/NNSA Aerial Measuring System surveys. Accurate simulations of winds and precipitation were important in source estimation, with wet deposition critical to modeling the northwest hot zone. Arguably, the best NARAC meteorology was provided by the Weather Research and Forecasting (WRF) model in Four-Dimensional Data Assimilation mode at 1-3 km resolution. As only dose-rate data were available to NARAC, *a priori* assumptions were made regarding the primary radionuclide contributors to dose. The radionuclides modeled were ^{133}Xe , ^{131}I , ^{132}I , ^{132}Te , ^{137}Cs , and ^{134}Cs , with relative activity ratios of 100:20:20:20:1:1 and 100:10:10:10:1:1 derived from limited field measurement data and reactor scenario analyses. Release rates were determined by optimization of the overall fit between model results and data paired in space and time, using both statistical (percentage of values with factor R, bias, etc.) and graphical metrics. Although NARAC found that a range of emission rates and quantities were consistent with the available data, all source estimates were within a factor of three of each other for the period of interest. These release amounts were similar to other studies that used different source estimation methodologies and radiological measurement data (Chino et al., 2011: *J. Nuc. Sci and Tech.* **48**, 1129-1134; Stohl et al., *Atmos. Chem. Phys. Discuss.* **11**, 28319-28394).

Fukushima source and dose estimation remains a challenging problem, due to multiple releases of long duration, rapidly changing reactor conditions, highly-variable meteorology, complicated geography, off-shore flow periods for which limited to no monitoring data are available, and the limited availability of measurement data during the early days of release, when the most significant releases are likely to have occurred.

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Corresponding author address:

Dr. Gayle Sugiyama
L-103 Lawrence Livermore National Laboratory
7000 East Avenue
Livermore, CA 94550
Tel: (925) 422-7266
Email: sugiyama@llnl.gov